Environmental Isotopes and Sulfate in a Water Supply Area at the Elbe River, Germany

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This work is mainly focused on the use of isotope data in order to assess the hydrochemical state and changes in a groundwater system used for drinking water production. It especially is related to dissolved sulfate, which was found to occur in higher concentrations locally. $\delta^{34}S$ values are scattering widely, showing a mixture of sources and processes in the system. In this work radioactive and stable environmental isotopes such as ^{3}H, ^{85}Kr, ^{14}C, ^{2}H and ^{18}O were applied to reveal residence times, mixing processes and the origin of water components and their relationships to the sulfate distribution.

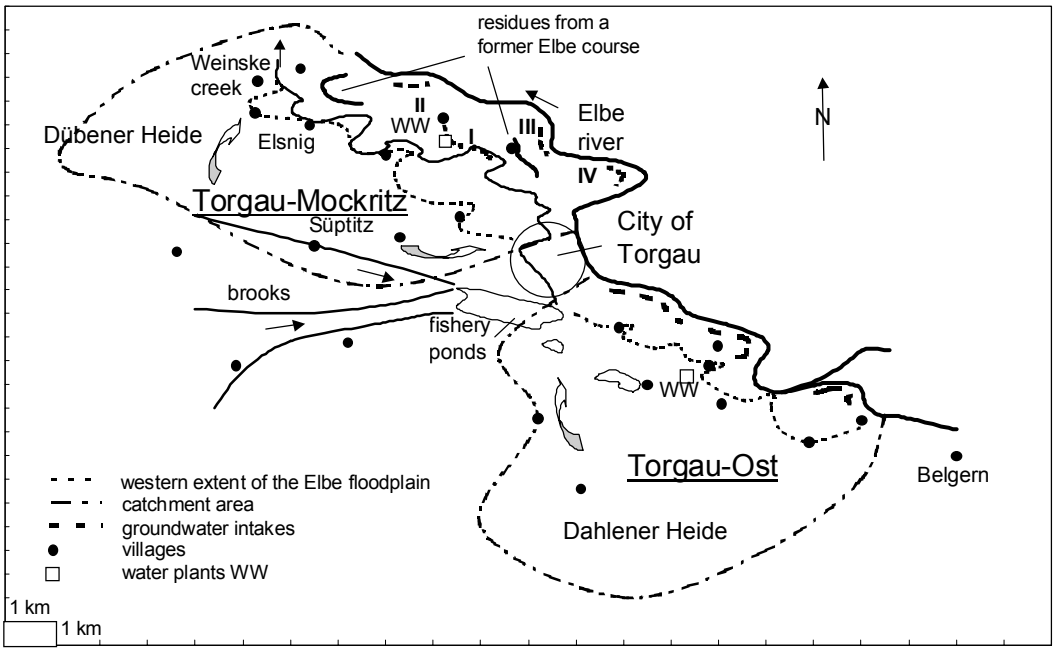

Fig.1 General map of the investigation field consisting of two catchment areas situated at the middle Elbe river

The produced water is a mixture of bank filtrate and regionally recharged groundwater. Bank filtration (Nestler et al. 1998) is known not to be the source of the high sulfate concentrations. All production wells are situated within an extended glacial valley roughly marked by the present Elbe course. The wells are installed in a 40 to 50 m thick aquifer formed by Holocene and Pleistocene sands and gravels covered by meadow loam. About 1 to 3 km west of the Elbe river the geological situation changes and the basin sediment strata are replaced by a hydrogeologically extremely complicated moraine system. This moraine region is thought to be the dominating recharge area of groundwater reaching the production wells from west.

To find out the range of residence times in the system ^{14}C was measured. Samples were taken from deep points in the Quaternary aquifer and from deep groundwater bearing layers in the moraine area. In such locations ^{14}C(DIC) concentrations as low as 25 pMC were obtained. These data were checked by ^{14}C(fulvic acid) measurements. Due to the corresponding values obtained by the two different methods we can be sure that the oldest waters have residence times of some thousands years. However, there is no hint that they contain Pleistocene com-

ponents. These waters show a low salt content and can therefore be excluded as the source of sulfate. Only in one case in the Torgau-Ost area higher mineralized waters from Permian sediments seem to ascend into the investigated aquifer (Mallén 2000).

The spatial distribution of the water within the aquifer below the flood plain was studied by means of tritium and $\delta^{18}O$. In all samples with very low tritium concentrations a low sulfate content was detected as well. Locally, the ^{3}H content of waters from sampling points near the aquifer base resembles that of recent precipitation. Additional ^{85}Kr measurements showed that the water in the lowermost sampling level of sampling points near the geological transition zone generally seems to contain an old component. The possible presence of a younger component is accompanied by an elevated sulfate content since younger water evidently acts as a carrier of dissolved sulfate.

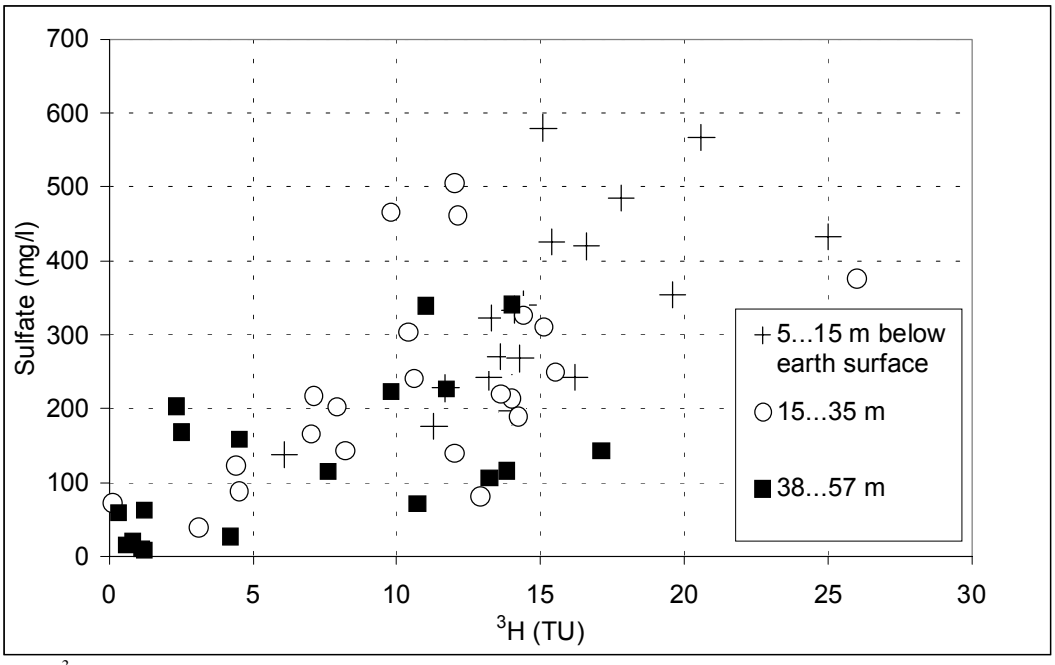

Fig.2 ^{3}H and sulfate in groundwater samples of Mockritz, sampling period: November 1995…May 1997

The comparison of the ^{3}H concentrations of 1995/96 and 1999 in the Mockritz area showed that the lowering of the sulfate concentration observed in that period in some sampling points cannot be referred to a reduced sulfate input but to changes in the hydraulic situation caused by a decreasing water demand and varying pumping conditions during the last years.

$\delta^{18}O$ and δD data suggest that surface water infiltrating from the creek Weinske and other sources can not be neglected in the sulfur balance of the Mockritz recharge area. The surface waters which can contribute dissolved sulfate to the aquifer as well are characterized by intermediate SO_4-concentrations. Thus, discussing the sulfate problem different water types have to be distinguished.

For a large number of groundwater samples with higher concentrations of dissolved sulfate an intermediate age can be assumed. Hence, the sulfate uptake from possible sulfur storage areas such as sedimentary sulfide accumulations is not necessarily connected to the groundwater recharge and vertical flow but can proceed by lateral flow involving older waters as well.

References:

Nestler, W., Walther, W., Jakob, F., Trettin, R. & K. Freyer (1998): Wassergewinnung in Talgrundwasserleitern im Einzugsgebiet der Elbe. - UFZ-Bericht Nr. 7/98, 204 S., ISSN 0948-9452

Mallén, G. (2000): Dissertation, Universität Leipzig, UFZ-Bericht Nr. 9/2000, 191 S., ISSN 0948-9452

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